UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

A LITERATURE REVIEW FOR MANAGEMENT

OF

THE MARTEN AND FISHER ON NATIONAL FORESTS IN CALIFORNIA

MAETON FREEL
LITERATURE REVIEW TEAM LEADER
FOREST BIOLOGIST
LOS PADRES NATIONAL FOREST

RONALD E. STEWART
REGIONAL FORESTER

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
PACIFIC SOUTHWEST REGION

JULY 1991

SUITABLE FURBEARER HABITAT CHARACTERISTICS

I. INTRODUCTION

This information has been developed by synthesizing available information from California research, over sixty furbearer references from across the country, and personal communications with some fifty biologists who have either conducted studies and research on furbearers or are actively involved in furbearer management as agency representatives. In addition, over thirty of these contacts have reviewed the entire package and offered comments which have been incorporated to the degree possible.

The habitat parameters presented in the following report represent a synthesis of the above information. The basic parameters were derived from a combination of categories presented in the U.S. Fish and Wildlife Service Habitat Suitability Models for the fisher (Martes pennanti) and marten (Martes americana); the Habitat Capability Models prepared by the Six Rivers National Forest (Region 5), USDA Forest Service Regions 1 and 6, and the Duncan Canyon Interagency Workgroup; and needs identified by Forests involved in the preliminary application of the recommendations.

Many of the parameters use assumptions derived from the above and, therefore, will require field validation. The information presented in this literature search should be refined as more research and monitoring information is generated and has been developed to assist in regional and forest level planning efforts.

II. ASSUMPTIONS AND WORKING PRINCIPLES (also see the assumptions following the habitat models)

A. Home range size appears directly related to habitat quality. Quality is defined by having high, moderate or low capability to support the species. The recommendations for size and spacing of the "furbearer" habitat conservation areas have been developed to support a combination of a larger male home range partially overlapped by at least two smaller female home ranges, recognizing that the best available information indicates that male home ranges are larger and spaced further apart than female home ranges, which are smaller and spaced more closely together. The size and spacing of home ranges probably varies depending on the habitat quality. Home ranges are probably larger for both sexes and spaced at greater distances in lower quality habitat. It was assumed that there is no overlap in home ranges of the same sex.

B. The combination of habitat areas for spotted owls, fisher, and marten should provide suitable amounts of the mature to old growth forest habitat to support Sierra Nevada red fox (Vulpes vulpes necator) and wolverine (Gulo gulo).

C. National Forests will be contributing to the maintenance of viable populations. It may not be possible for a forest to sustain a population by itself. Therefore, the maintenance of old growth and mature habitat management areas will be coordinated between adjacent forests and other land management agencies to provide connection of suitable habitat areas to ensure interaction between individuals and maintain viability throughout their range.

D. Fisher and marten compete for den sites and food (deVos 1952), and stomach content examinations have shown fisher eat marten. It is hypothesized that interspecific competition may partially limit the overlap of populations of these animals. In actual application of this literature search, it appears that the species' habitat may overlap geographically, but with some separation related to elevation, snowfall, and habitat characteristics. Work in Maine (Krohn 1989, Arthur 1989) indicates fairly distinctive differences in habitat types selected by fisher and marten. This indicates the potential need to provide separate marten and fisher habitat management areas in appropriate habitats.

III. HABITAT CHARACTERISTICS

A. HABITAT CHARACTERISTICS FOR FISHER (Martes pennanti)

SUMMARY: In California, fisher most often occur at somewhat lower elevations than marten, between 2000-5000 feet in the North Coast region and 4000-8000 feet in the southern Sierra Nevada (Grinell et al. 1937, Ingles 1965, Orr 1949).

Preferred habitat is characterized by dense (60-100% canopy) multi-storied, multi-species late seral stage coniferous forests with a high number of large (> 30 inch dbh) snags and downed logs. These areas also include close proximity to dense riparian corridors and saddles between major drainages or other landscape linkage patterns used as adult and juvenile dispersal corridors, and an interspersion of small (<2a.) openings with good ground cover used for foraging. Numerous and heavily travelled roads are not desirable to avoid habitat disruption and/or animal mortality. Occasional one and two lane forest roads with moderate levels of traffic should not limit marten and fisher movements.

The stand structure mix in the following table appears to be skewed towards a mature/old growth component, especially when compared to the data from Canada, the midwest, Maine, and other locations. Other studies indicated that fisher apparently use greater percentages of mid-early seral stages for foraging in summer months although they still appear to need and utilize the mature/old growth stands for denning, especially in areas with high snowfall.

Preferred WHR habitat types include Montane hardwood-conifer, mixed conifer, Douglas-fir, redwood, montane riparian, Jeffrey pine, ponderosa pine, lodgepole pine, subalpine conifer, aspen, eastside pine and possibly red fir. Predominant use is of the Douglas-fir and mixed conifer in the north coast and mixed conifer in the southern Sierra Nevada.

TABLE 1. HABITAT PARAMETERS FOR FISHER
(Martes pennanti)

SEASON: Year-round

HABITAT PARAMETER	HIGH [1]	MODERATE	LOW
1. Home range [2]	6000a. 8 mile linear limit (Buck 1989)	9800a. >8 miles:actual limit undefined	11,300a. >8 miles:actual limit undefined
2. Seral Stage:			
a. Denning/Resting	5 (old growth) 4 (mature)	5,4	5,4
b. Foraging	5,4,3 (midsuccession)	5,4,3	5,4,3
3. Minimum Stand Size [3]	>120a. adj. mature timber	80-119a. adj. mature timber	60-79a. adj. mature timber
	>500a. adj. open canopy areas	200-499a. adj. open canopy areas	120-199a. adj. open canopy area
4. Denning/Resting Canopy Closure[4,18] [Verner & Boss WHR]	>80% WHR CLASS C	61-80% WHR CLASS B	40-60% WHR CLASS B
5. Home Range Stand Structure [5,17,18]	70-80% mature closed conifer (≥4C) If unavail. 50-60% >4C & 20-30% ≥4B	60-70% mature closed conifer (≥4C) If unavail. 40-50% ≥ 4C & 20-30% ≥ 4B	50-60% mature closed conifer (≥4C) If unavail. 30-40% ≥ 4C & 20-30% ≥ 4B
	25-30% mixcon/ hardwoods (≥4B) If unavailable 15-20% >4B or 3C 10-15% ≥3C or 3B	25-30% mixcon/ hardwoods (≥4B) If unavailable 10-15%≥4B or 3C 10-15%≥3C or 3B	30-40% mixcon/ hardwoods (≥4B) If unavailable 15-20%≥4B or 3C 15-20%≥3C or 3B
	5% hardwood/other (≥4A HW/≥3A-4A for other)	5-10% hardwood/ other(≥4A HW/ ≥3A-4A other)	10-20% hardwood/ other (≥4A HW/ ≥3A-4A other)
6. Riparian/wet meadow proximity to denning resting habitat [6]	<1/4-1/2 mile	1/2-1 mile	1-2 miles

7.	Vertical Diversity Denning, Resting, Foraging Areas [16]	3-4 layers plus shrubs	2-3 layers plus shrubs	2 layers plus shrubs
8.	Openings [12] without Cover	<1a. each	1-2a. each	2-3a. each
9.	Minimum Snag Densities [8]:			
a.	Resting/Denning[9] (4-5C stands)(size)	≥2/acre ≥44"dbh	1-2/acre ≥30-43"dbh	0.5-1/acre ≥24-29"dbh
b.	Other Snags/(No. (foraging use)	4-5/acre >20"dbh	2-3/acre >20"dbh	1/2-1/acre >15"dbh
10.a.	Live Tree Snag (for dens)	>6/a. >44"dbh	3-6/a. 30-43"dbh	1.5-3/a24-29"dbh
b.	Replacements (foraging)	12-15/a. >20"dbh	9-18/a. >20"dbh	4.5-9/a. >15"dbh
11.	Downed logs[10] (hunting use)	>4/acre >30"x15'	2-3/acre >20"x15'	1-2/acre >20"x15'
12.	Road Density[11]	0-<1/2mi/mi^2	1/2-2mi/mi^2	2-3 mi/mi^2
13.	Travel Corridor Width [13]	≥600ft within mature stands ≥1200ft adj. to clearcuts	300-599ft within mature stands 600-1199ft adj. to clearcuts	100-299ft within mature stands 300-599ft adj. to clearcuts
14.	Travel Corridor Canopy Closure [5,6,7]	>60%	50-60%	40-50%
15.	Habitat Spacing Distance [14]	≤ 3 miles	3-8 miles	>8-12 miles

Footnotes in brackets [1-19] refer to the attached list of assumptions.

B. HABITAT CHARACTERISTICS FOR MARTEN (Martes americana)

SUMMARY: In California, marten most often occur at somewhat higher elevations than fisher, although the Humboldt subspecies occur from 200 feet above sea level to 9000 feet with the average at 4700 feet (Schempf and White 1977). The elevational records for the northern Sierra Nevada ranged from 3,400 feet up to 10,400 feet averaging 6,600 feet. For the southern Sierra Nevada the range was from 4,000 feet to 13,100 feet averaging 8,300 feet elevation.

Preferred habitat is characterized by dense (60-100% canopy), multi-storied, multi-species late seral coniferous forests with a high number of large (> 24 inch dbh) snags and down logs. These areas also include close proximity to dense riparian corridors used as travelways, and an interspersion of small (<1 a.) openings with good ground cover used for foraging. Numerous and heavily travelled roads are not desirable to avoid habitat disruption and/or animal mortality. Occasional one and two lane forest roads with moderate levels of traffic should not limit marten and fisher movements.

Preferred WHR habitat types include mature mesic forests of red fir, red fir/white fir mix, lodgepole pine, Sierran mixed conifer and Klamath mixed conifer.

TABLE 2. HABITAT PARAMETERS FOR MARTEN
(Martes americana)

SEASON: Year-round

HABITAT PARAMETER	HIGH [1]	MODERATE	LOW
1. Home range [2]	1400a.	2100a.	2500a.
2. Seral Stage:			
a. Denning/Resting	5 (old growth) 4 (mature)	5,4	5,4 5,4
b. Foraging	5,4,3 (midsuccession)	5,4,3	4,3
3. Minimum Stand Size [3]	>120a. adj. mature stands	80-119a. adj. mature stands	60-79a. adj. mature stands
	>500a. adj. open canopy areas	200-499a. adj. open canopy areas	120-199a. adj. open canopy areas
4. Denning, Resting Canopy Closure[4,18] (*Verner&Boss WHR)	>70% WHR Class C	41-70% WHR Class B,C	30-40% WHR Class A,B
5. a. Stand Structure [5,17]	50% mature (≥4C)	35% mature(≥4C)	25% mature(≥4C)
	if unavailable: 35% >4C and 15% ≥4B	if unavailable: 20% >4C and 15% ≥4B	if unavailable: 15% >4C and 10% ≥4B
	30% ≥4B if unavailable: 15% >4B or 3B 15% ≥3C or 3B	45% ≥4B if unavailable: 25% ≥4B and 20% ≥3C or 3B	55% ≥4B if unavailable: 30% >4B and 25% ≥3C or 3B
	20% ≥4A/other	20% ≥4A/other	20% ≥4A/other
b. Basal Area [15]	≥350 ft	176-350 ft	75 ft
6. Riparian/wet meadows: proximity to closed canopy stands [6]	<1/4 mile	1/4-1/2 mile	1/2-1 mile
7. Vertical Diversity	No pertinent information available		
8. Openings [12]	<1a. each	1-2a. each	2-3a. each

9. Minimum Snag Densities [8]:			
a. Resting/Denning [9]	≥3/acre (>24" dbh)	2-3/acre (24" dbh)	1-2/acre (20-23" dbh)
b. Foraging	>3/acre (>15" dbh)	3/acre (>15" dbh)	2/acre (>15" dbh)
10.a. Live Tree Snag (dens)	>9/a. (>24"dbh)	6-9/a. (>24"dbh)	3-6/a. (>24")
b. Replacements(forage)	>9/a. (>15"dbh)	9/a. (>15"dbh)	6/a. (>15"dbh)
11. Dead and Downed Logs	≥20/a. (≥15" x 15')	10-19/a. (≥15" x 15')	5-9/a. (≥15" x 15')
12. Road Densities[11] Paved	<1 mi/mi^2	1-2 mi/mi^2	2-3 mi/mi^2
13. Travel Corridor			
a. Canopy Closure[5,6,7]	>60%	50-60%	40-50%
b. Width [6,7,13]	>300ft w/in mature stands	150-299ft w/in mature stands	100-149ft w/in mature stands
	>600ft adj. open/no canopy	300-599ft adj. open/no canopy	200-299ft adj. open/no canopy
14. Habitat Spacing [14]	≤2 miles	>2-3 miles	>3-6 miles

Numbers in brackets [1-19] refer to the attached list of assumptions.

DOCUMENTATION OF ASSUMPTIONS AND REFERENCES USED
FOR DEVELOPMENT OF
REGION 5 FURBEARER INFORMATION

ASSUMPTION 1: HABITAT DEFINITIONS

High capability habitat is defined as habitat which supports a stable population of fisher and/or marten where home ranges occur at relatively high densities suggesting abundant availability of preferred habitat characteristics and high prey densities.

Moderate capability habitat is defined as habitat which supports a stable population of fisher and/or marten where home ranges occur spaced at lower densities than in 'high' capability habitat, with lesser availability of preferred habitat characteristics and lower prey densities.

Low capability habitat is defined as habitat which cannot independently support a stable population of fisher and/or marten. Home ranges include low capability habitat but generally also include moderate and high quality habitat. Preferred habitat characteristics occur in limited quantities and limited prey is available. Areas of low capability habitat may occur as inclusions among high and moderate capability portions of a habitat management area. Complete habitat management areas of low potential should not occur unless the options for the location of these habitat management area(s) and linkage corridors are limited by site potential, and the area is significant in the desired spatial array of habitat management areas for a viability strategy.

Unsuitable habitat is defined as habitat which cannot independently support a stable population of fisher and/or marten. Preferred habitat characteristics generally do not occur and limited prey is available. Some animals may occasionally disperse through or be temporarily present in these areas but reproductive populations of marten/fisher are not expected to occur.

Habitat capability relates to the ability of an area to provide adequate abundance and distribution of prey, cover, reproductive and resting sites and dispersal corridors.

ASSUMPTION 2: HOME RANGE SIZES

Recommendations for home range sizes and distributions for each species incorporate interpretations of habitat quality parameters plus the recognition that the home ranges of fisher and marten males are larger and spaced further apart than the home ranges of fisher and marten females. Reproductive potential varies depending on habitat quality. An average of 3 young per female were produced in high and moderate areas (Leonard 1986, Strickland et al. 1982, Wright and Coulter 1967); in less suitable habitat the rate was less than 2 young per female (Hamilton 1958; Coulter 1966; Strickland et al. 1982). An estimated 50% survival rate was assumed for young produced (Arthur et al. 1989). It was assumed that there is little to no overlap in territories of adult males, however, that female/male ranges can significantly overlap especially during the breeding season (Buck et al. 1983, Powell 1982, Johnson 1984, Simon-Jackson 1989). For California fisher the mean overlap of adult male and females was 40% (Buck et al. 1983). Since California studies tended to have smaller home ranges than other studies, it was assumed that the habitat quality described represents high quality habitat. The moderate and low quality categories utilize mean home range from a cross section of studies as they are thought to represent the variation of home range sizes better than the few California data points.

TABLE 3. FISHER HOME RANGE DATA:

Source	Date	Location	Male Home Range	Female Home Range
Kelly, G.M.	1977	New Hampshire	M= 8.0sq.mi.= 5120a.	F= 6.0sq.mi.= 3840a.
Buck, et al	1983	California	M= 7.2 (n=13) = 4608a.	F= 2.2 (n=7) = 1408a.
Powell, R.A.	1982	Michigan	M= 13.5 = 8640a.	F= 6.0 = 3840a.
Johnson,S.A.	1984	Wisconsin	M= 15.0 = 9600a.	F= 3.0 = 1920a.
Douglas and Strickland	1987	Misc. Loc.	M= 10.9 = 6944a.	F= no data given
de Vos, A.	1952	Canada	M= 10.0 = 6400a.	F= no data given
Allen, A.W.	1983	U.S.	M= 8.9 (n=7) = 5664a.	F= no data given
Arthur,	1989	Maine *	M= 11.9 (n=6) = 7635a.	F= 6.3sq.mi.= 4028a.

Mean home range for male fisher = 6826 acres.

Mean home range for female fisher = 3007 acres.

Mean home range needed in **low capability habitat** (one male plus three females with approximately 50% overlap of each female home range with the male home range) = 6826a. per male + 1504a. per each female = 11,300a. = **11,300a.**

Mean home range needed in **moderate capability habitat** (one male plus two females with approximately 50% overlap of each female home range with the male home range) = 6826a. per male + 1504a. per each female = 9,834a. = **9,800a.**

Mean home range needed **in high capability habitat** (as defined by California data-one male plus 2 females) = 4,608a. per male + 704 a. per each female = 6,016 a. = **6,000 a.**

TABLE 4. MARTEN HOME RANGE DATA:

Source	Date	Location	Male Home Range	Female Home Range
Hawley and Newby	1957	Montana	(n=6) M=0.9 sq mi= 595a.	(n=5) F=0.3 sq mi= 173a.
Francis and Stephenson	1972	Ontario	(n=4) M=1.4 sq mi= 896a.	(n=4) F=0.4 sq mi= 269a.
Mech and Rogers	1977	Minnesota	(n=3) M=6.1 sq mi=3706a.	(n=1) F=1.7 sq mi=1062a.
Clark and Campbell	1977	Wyoming	(n=2) M=0.8 sq mi=544a.	(n=1) F=0.3 sq mi=198a.
Simon	1980	California	(n=5) M=1.1 sq mi=692a.	(n=3) F= sq mi=768a.
Spencer	1981	California	(n=1) M=1.89 sq mi=1210a.	(n=3) F=1.13 sq mi=724a.
Martin	1987	California	(n=6) M=0.66 sq mi=422a.	(n=4) F=0.39 sq mi=247a.
Soutier	1979	Maine	(n=81) M=1.74 sq mi=1088a.	(n=42) F=0.9 sq mi=576a.
Archibald and Jessup	1984	Yukon	(n=4) M=2.4 sq mi=1536a.	F=1.8 sq mi=1152a.
Davis	1978	Wisconsin	M=no data	F=3.0 sq mi=1920a. F=3.2 sq mi=2048a.
Wynne and Sherbourne	1984	Maine	(n=3) M=2.2 sq mi=1408a.	(n=2) F=1.1 sq mi=704a.
Steventon and Major	1982	Maine	(n=3) M=3.2 sq mi=2048a.	(n=1) F=0.9 sq mi=576a.
Buskirk	1983	Alaska	(n=9) M=2.5 sq mi=1600a.	(n=3) F=1.4 sq mi=896a.

Mean home range for male marten = 1312 acres.

Mean home range for female marten = 808 acres.

Mean home range needed **in low capability habitat** (one male and two females with approximately 50% overlap of each female home range with the male home range) = 1312a. per male and 404 a. per female = 2524a. = **2500 acres.**

Mean home range needed **in moderate capability habitat** (one male and two females with approximately 50% overlap of each female home range with the male home range) = 1312a. per male and 404a. per female = 2120a. = **2,100a.**

Mean home range needed **in high capability habitat** (as defined by California data) equals 775a. per male and 290a. per each female = **1,400 a.**

ASSUMPTION 3: MINIMUM STAND SIZE

The minimum stand sizes were derived from literature relating to the effects of fragmentation in forest ecosystems and specifically relates to "effective habitat island size". The major reference was Harris (1984:108-112), which summarizes a number of other authors on the subject. Also, Rosenberg and Raphael (1986), and Raphael (1982); Raphael (1989) identified minimum stand size for furbearers as 25ha (60a.). This was for presence/absence only and did not identify if these areas were used for breeding, foraging or travel.

ASSUMPTION 4: CANOPY CLOSURE

These figures come from published literature and theses (Kelly 1977, Coulter 1966, Powell 1982, Buck et al. 1979, Simon 1980, Spencer 1981, Martin 1987), and from the interagency workgroup assembled for the Duncan Canyon EIS in June 1989.

ASSUMPTION 5: STAND STRUCTURE

These figures come from the literature cited below and as developed by the Duncan Canyon workgroup. In all cases, the highest number of acres of the highest habitat capability are used, keeping habitat areas as contiguous as possible. Current information from Maine and Canada suggests that fisher may utilize second growth more than indicated in this table. As more local data becomes available the percentages of old/mature to second growth may change although the need for good (>40%) canopy closure still applies equally for all seral stages.

ASSUMPTION 6: IMPORTANCE OF RIPARIAN CORRIDORS

This information was derived from the literature and with the Duncan workgroup. It is based on field observations and radiotracking information from several researchers. These riparian corridors are especially important when containing meadow-forest edges which are highly utilized for foraging/hunting areas and as travelways. (See also Harris 1984, de Vos 1951, 1952, Kelly 1977, Buck et al. 1983).

ASSUMPTION 7: TRAVEL CORRIDOR LOCATIONS

Again, as with the riparian information this conclusion is based on field observations and recommendations of field researchers. These corridors are oriented along creeks and through saddles over ridgetops (Powell 1982, Buck et al. 1983, Duncan Workgroup 1989). Where there are established roads within riparian areas, the riparian corridors can still serve as movement corridors or for foraging or even denning, if the road density, plant community disturbance and level of human activity will be low enough in these areas so that the animals are not deterred from using the corridors.

ASSUMPTION 8: SNAG REQUIREMENTS

The use of snags and down logs is well documented in the literature cited below for both species. The snag numbers and size classes were derived from research data in California on marten and fisher (Buck et al. 1979, 1983; Simon 1981; Martin 1987). Snags of all species and decomposition states are included and well distributed throughout the habitat areas. Replacement live culls are managed for also in like numbers as presented in the model.

ASSUMPTION 9: RESTING/DENNING SNAGS

Snags greater than 24" dbh were preferred for denning by martens (Simon personal communication 1989), and snags greater than 44"dbh are preferred for denning by fisher (Buck personal communication 1989). In general, the largest snags available in a stand should be retained and managed for resting and denning use.

ASSUMPTION 10: DOWNED LOG REQUIREMENTS

Again, use of downed logs is well documented and recommendations were derived from research data from California studies cited above. In all cases, the largest logs available are retained. Ground surface covered by downfall ranging from 20-50% is assumed optimal (Allen 1982). Logs in all decay classes should be provided.

ASSUMPTION 11: ROAD DENSITIES

This information has not been directly documented in the field for the marten or fisher, however it is based on research conducted relating to disturbance for deer and elk (Lyon 1984; Perry and Overly 1977) and for wolf and wolverine (Solis personal communication 1989). Buck (1989), emphasized minimizing the presence of roads by obliterating all old un-needed roads and the need for locating any new roads away from ridges, saddles and riparian zones. Arthur, et al. (1989), found only limited crossing of dirt roads even when forested on both sides; also that home ranges were in relatively contiguous blocks with roads at the perimeters. In contrast, recent radiotelemetry studies indicate that marten and fisher readily cross forest roads, however, animal mortality can be expected to increase with increases in vehicle trips (M. Raphael, Pers. Commun.). Roads are apparently not a barrier to animal movement, however, they

are undesirable as a general feature of a habitat management area because of the disturbances associated with them. Where there are established roads within habitat management areas, the areas adjacent to the roads may still be used if the road density, plant community disturbance and level of human activity is low enough in these areas so that the animals are not deterred from using the peripheral areas.

ASSUMPTION 12: OPENINGS

The information relating to the appropriate size of openings is based on professional judgments and field observations of the California researchers cited above. They were derived by consensus by the Duncan Canyon interagency workgroup (1989). In addition, Koehler and Hornocker (1977), Hargis (1981), and Spencer (1981), all reported that marten rarely venture over 150 feet from cover therefore optimum openings should not exceed 300 feet in width for marten use.

Powell (1982), Buck et al. (1983), Arthur et al. (1989), and other fisher literature emphasizes the avoidance of openings by fishers. They may use previously cut areas, especially during summer, if good ground canopy or other low closed canopy (>30%) is present to provide cover. An appropriate amount of downed logs and standing trees, either single or in small groups need to be left in openings to provide needed cover.

ASSUMPTION 13: CORRIDOR WIDTH

These figures are based on literature (Harris 1984) and the professional judgment of Jones (1989), Buck (1989), and Solis (1989). Powell (1989), also emphasized that the greater the length of a corridor the wider it should be, and the percent of canopy closure should increase as distance increases.

ASSUMPTION 14: HABITAT SPACING DISTANCE

These figures apply to the distance between habitat management units, not the spacing of components within a home range. (It is recommended that stands within a home range not be over 1/2 mile apart and connected by suitable dispersal linkages).

Powell (1989) stated that he considered optimal habitat to contain contiguous home range areas not separated by any distances, and anything greater than 8 miles apart as unavailable. For marten, information from Burk (1982) recommends 2 miles, and from Region 6, Forest Service, which has adopted a standard of 3 miles spacing when there is more than one adjacent habitat area available (Region 6 MMR letter of April 16, 1984). Fisher distances are based on data from Buck (1983), Jones (1989) and Powell (1989).

ASSUMPTION 15: BASAL AREA

These figures come from Simon-Jackson (personal communication 1989) as derived from her research data.

ASSUMPTION 16: VERTICAL DIVERSITY

Due to the variability in stand structure potential among the various habitat types some geographic areas may only have the potential for 3 layers while others may have 4 potential layers. Management, therefore, should be to create the maximum number of vertical layers possible under natural conditions as determined by the vegetation type and geographic location of the site (Buck 1989, Solis 1989).

ASSUMPTION 17: FORAGING CANOPY COVER

Class 3A-4A canopy closure equals ≥30 % canopy cover. Areas with less than 30% cover are considered unsuitable.

ASSUMPTION 18: DEFINITIONS OF STAND CLASSES

The definition of stand classes relies on the measured inches dbh and percentage canopy closure, not on any classification scheme. Do not substitute seral classes or timber closure classes for the actual numeric measurements. In the following table note that stage 5 includes multi-dominant large trees.

SERAL STAGES:	HEIGHT RANGE (feet)	DBH RANGE (inches)
1 = grass/forb	0.2	<1
2 = seedling/sapling	<20	1-6
3 = pole/medium	20-50	6-24
4 = large tree	>50	>24
5 = multi-layer large tree	>50	>24

CANOPY CLOSURE CLASSES:

TIMBER CLASS		WHR CLASS		PERCENT CLOSURE
S	=	A	=	<20%
P	=	A	=	20-39%
N	=	B	=	40-69%
G	=	C	=	70+%

The following chart shows a comparison of the Region 5 Timber Typing and Wildlife Habitat Relationships classification schemes:

SERAL STAGES

Mean Tree Diameter	Region 5 TM HANDBOOK	California WHR System	Verner & Boss 1980
-	1 Seed/Sap	1 Seedling 2 Sapling	1 Grass/Forb
< 12"	2 Pole	3 Pole	2 Seed/Sap
12-24"	3 Sm.Tree	4 Sm.Tree	3 Pole/Med.
24-40"	4 Md.Tree	5 Md.Tree	4 Large Tree
> 40"	5 Lg.Tree	5 Lg.Tree	4 Large Tree
> 1 Story	6 Mlt.Layer	6 Mlt.layer	4 Large Tree

CANOPY CLOSURE CLASSES

Canopy Closure	Region 5 TM HANDBOOK	California WHR System	Verner & Boss 1980
10 - 19 10 - 24%	S - Sparse	S - Sparse	A - Open
20 - 39 25 - 39%	P - Light	P - Open	A - Open
40 - 59 40 - 69	N - Medium	M - Mod.	B - Mod.
> 60% > 70%	G - Heavy	D - Dense	C - Dense
>2 Stories	6 Mlt.Layer	6 Mlt.layer	C - Dense

Note: For fisher and marten management purposes, cover less than 30% is considered unsuitable for use. Therefore, even though tables indicate Sparse or Class A cover is acceptable for travelway purposes this is only true down to 30%. Actual areas in the field with less than 30% canopy cover would be considered unsuitable and lumped as part of the opening category.

ASSUMPTION 19: LIVE TREE REPLACEMENT NEED

Due to the natural loss of snags due to decay, fire, blowdown, etc. it is necessary to retain and manage a number of live trees as replacement snag trees. The exact number required varies from species to species and from size class to size class. Raphael (1989) indicated that a general rule is to retain at least 3 times the number of live trees as you wish to manage for as snags. Formulas to calculate these specific needs can be found in Morrison (1987).

REFERENCES

GENERAL FURBEARER/HABITAT REFERENCES:

Arthur, S.M. and W.R. Krohn 1988. An annotated bibliography of predator research ion Maine, 1974-1988. Maine Agricultural Experiment Station, University of Maine, Technical Bulletin 132, August 1988.

Duncan Canyon Interagency Workgroup 1989. Workgroup assembled to review proposed timber sale and formulate proposed management guidelines for the Tahoe National Forest. Members included: Slader Buck (fisher researcher); Dr. Archie Mossman (Cal. St. Univ. Humboldt, fisher researcher); Dr. Reg Barrett (Univ. of California, Berkeley-researcher); Teri Simon-Jackson (marten researcher); Gordon Gould and Ron Schlorff (Calif. Dept. Fish & Game, non-game biologists); Jeff Finn (CDFG unit manager); and Joelle Buffa, Maeton Freel, Jeff Mattison, Mike Chapel, Mariann Armijo (Forest Service biologists); and Julie Lydick and Phil Tuma (Forest Service Foresters).

Franklin, J. F. et al. 1981. Ecological characteristics of old-growth douglas-fir forests. USDA, Forest Service, Gen. Tech. Rept. PNW-118.

Grinnell, J., J.S. Dixon, and J.M. Linsdale 1937. Fur-bearing mammals of California, Vol. 1. Univ. Calif Press, Berkeley, CA. pp.184-210.

Harris, Larry D. 1984. The fragmented forest: island biogeography theory and the preservation of biotic diversity. University of Chicago Press, Chicago, Ill. 211 pp.

Lyon, Jack. L. 1984. Road effects on wildlife and fisheries. paper presented at forest transportation symposium, Dec. 1984. USDA, FS, Intermountain Forest and Experiment Station, Missoula, Mt.

Perry, C. and R. Overly 1977. Impacts of roads on big game distribution in portions of the Blue Mountains of Washington. 1972-73. Washington Game Department. Applied Research Section, Bulletin 11. Olympia, Washington.

Raine, R. M. 1983. Winter habitat use and responses to snow cover of fisher (Martes pennanti) and marten (Martes americana) in southeastern Manitoba. Can. J. Zool. 61:25-34.

Raphael, M.G. 1990. USDA,FS, PNW Range and Experimental Station, Olympia, Washington. Personal communication. October 1990.

Raphael, M.G. 1989. USDA,FS, PNW Range and Experimental Station, Olympia, Washington. Personal communication. August 1989.

Raphael, M.G. 1988. Long-term trends in abundance of amphibians, reptiles, and mammals in douglas-fir forsts of northwestern Califronia. Proceedings of Management of amphibians, reptiles and small mammals in North America. Flagstaff, Arizona July 1988. USDA,FS, Gen. Tech Report RM-166.

Raphael, M.G. and M.L. Morrison. 1987. Decay and dynamics of snags in the Sierra Nevada, California. Forest Science, 33(3):774-783.

Raphael, M.G. 1984. Wildlife populations in relation to stand age and area in douglas-fir forests of northwestern California. In Meehan,W.R. et al. (eds) 1984. Fish and wildlife relationships in old-growth forests. Juneau,Alaska 1982.

Raphael, M.G. and R.H.Barrett 1983. Diversity and abundance of wildlife in late successional douglas-fir forests. New Forests for a Changing World, Proceedings of 1983 SAF National Convention.

Rosenberg, K.V. and M. G. Raphael 1986. Effects of forest fragmentation on Vertebrates in Douglas-fir forests. Wildlife 2000, Wisconsin Press, Madison. pp263-272.

Schempf, P.F. and M. White 1977. Status of six furbearer populations in the mountains of northern California. USDA,FS, R5, San Francisco. 51pp.

Solis, David 1989. USDA, FS, Six Rivers National Forest. Personal communications.

Thomasma, L.E. 1988. A test of the habitat suitability index model for the fisher (Martes pennanti) in the upper peninsula of Michigan. Master's Thesis, Michigan Technological University.

Verner, J. and A. Boss 1980. California wildlife and their habitats: western Sierra Nevada. USDA, FS, Gen. Tech. Report PSW-37. Berkeley, Ca. 439pp.

FISHER:

Allen, A.W. 1983. Habitat suitability index models: Fisher. USDI, Fish and Wildlife Service. FWS/OBS-82/10.45. 19pp.

Arthur, S.M., W.B. Krohn and J.R. Gilbert. 1989. Home range characteristics of adult fishers. J. Wildl. Mgmt. 53(3):674-679.

Arthur, S.M., W.B. Krohn and J.R. Gilbert. 1989a. Habitat use and diet of fishers. J. Wildl. Mgmt. 53(3):680-688.

Arthur, S.M., W.B. Krohn, and T.F. Paragi. 1989. Fishers and forests (abstract). Forest and Wildlife management in New England: What can we afford. Proceedings of a joint meeting of the New England SAF, Maine Chapter of TWS, and Atlantic International Chapter of the AFS,. Maine Ag. Exper. Station, Misc. Pub. (in press).

Buck, S.C. 1989. US Marine Corps Base at Camp Pendleton, California. Personal communication, June and August 1989.

Buck, S. C., C. Mullis,and A. Mossman. 1983. Final Report: Corral bottom-hayfork bally fisher study. Presented to U.S. Forest Service, San Francisco, Ca. 136pp.

Buck, S.C. et al. 1979. A radio telemetry study of fisher in northwestern California. Cal-Neva Wildl. 1979:166-172.

Buskirk, Steven W. and L.L. McDonald 1989. Analysis of variability in home-range size of the American marten. J. Wild. Manage. 53(4):997-1004.

Coulter, M. W. 1966. The ecology and management of fishers in Maine. PhD thesis. Syracuse University, New York.

de Vos, A. 1952. Ecology and management of fisher and marten in Ontario. Ontario Dept. Lands and Forests. Tech. Bull. 90pp.

Douglas, C.W. and M.A. Strickland 1987. Fisher. In Wild Furbearer management and conservation in north america. Ministry of Natural Resources. Ontario, Canada. pp511-529.

Grenfell, W.W. and M. Fasenfest. 1978. Winter food habits of fishers, Martes pennanti, in northwestern California. Cal. Fish and Game (3):186-189.

Grossenheider, R.P. and W.H. Burt 1964. A field guide to the mammals. Houghton Mifflin Press, Boston, Ma.

Hamilton, W.J. and A.H. Cook 1955. The biology and management of the fisher in New York. New York Fish and Game Journal 2:13-35.

Ingles, L.G. 1965. Mammals of the pacific states; Calif., Oregon, Washington. pp371-372. Stanford University Press, Stanford, Ca.

Johnson, S.A. 1984. Home range, movements, and habitat use of fishers in Wisconsin. M.S. Thesis, Univ. Wisc.,Stevens Point. 78pp.

Jones, Jeff 1989. USDA, FS, Beaverhead National Forest. Personal Communication relating to MS Thesis work ongoing on Fisher.

Jones, Jeff 1990. Preliminary data from Idaho fisher study. University of Idaho, February 1990.

Kelly, G.M. 1977. Fisher (Martes pennanti) biology in the White Mountain National Forest and adjacent areas. PhD. Thesis, Univ.Mass.,Amherst. 178p.

Kuehn, David W. 1989. Winter foods of fishers during a snowshoe hare decline. J. Wildl. Mgmt. 53(3)688-692.

Leonard, R.D. 1986. Aspects of reproduction of the fisher, Martes pennanti, in Manitoba. Canadaian Field-Naturalist 100:32-44.

Powell, Roger 1982. The Fisher: Life history, ecology and behavior. Univ. of Minnesota Press, Minnesota. 217pp.

Raine, R.M. 1982. Ranges of juvenile fisher, Martes pennanti, and marten, Martes americana, in southeastern Manitoba. Canadian Field-Nat. 96:431-438.

Slough, Brian G. 1989. Movements and habitat use by transplanted marten in the Yukon Territory. J. Wildl. Manage. 53(4) :991-997.

Strickland, M.A., C. Douglas, M. Novak, and N. Hunziger 1982. Fisher in Wild mammals of North America. J.A. Chapman and G.A. Feldhamer, eds. pp. 586-598.

Wright,P.L. and M.W. Coulter 1967. Reproduction and growth in Maine fishers. J. Wildl. Mgmt. 31:70-87.

MARTEN:

Allen, A.W. 1982. Habitat suitability index models. Marten. USDI, FWS. FWS/OBS-82/10.11. 9pp.

Archibald, W.R. and R.H.Jessup 1984. Population dynamics of the pine marten (Martes americana) in the Yukon Territory, pages 81-97 in Olson, R. and R. Hastings and F. Geddes, eds. Northern ecology and resource managment. Univ. Alberta press, Edmonton.

Barrett, R.H. and W. D. Spencer 1982. Supplemental Report on a test of a pine marten habitat suitability model for the northern Sierra Nevada. Univ. of Calif. Berkeley, College of Natural Resources, Dept. of Forestry and Resource Management. Performed for USDA, Forest Service, R5-San Francisco, CA.

Burke, T.E. 1982. Marten. Unpublished report, Colville National Forest, Washington. 6pp. as reported in USDA,FS, Marten Model for Region 1, Missoula, Montana.

Buskirk, S.W. 1983. The ecology of marten in southcentral Alaska. PhD. Thesis Univ. of Alaska, Fairbanks. 131pp.

Buskirk, S.W. and L.L. McDonald 1989. Analysis of variability in home-range size of the American marten. J. Wildl. Manage. 53(4):997-1004.

Clark, T.W. and T.M. Campbell 1977. Short-term effects of timber harvest on pine marten behavior and ecology. Idaho St. Univ. Pocatello. 60pp.

Davis, M.H. 1978. Re-introduciton of the pine marten into the Nicolet National Forest, Forest County, Wisconsin. M.S. Thesis, Univ. Wisc., Stevens Point. 64pp.

Francis, G.R. and A.B. Stephenson 1972. Marten ranges and food habits in Algonquin Provincial Park, Ontario. Ont. Minist. Nat. Res. Rep.91. 53pp.

Hargis, C.D. 1981. Winter habitat utilization and food habits of pine marten in Yosemite National Park. MS Thesis. Univ. Calif., Berkeley. 57pp.

Hargis, C.D. and D. R. McCullough 1984. Winter Diet and habitat selection of marten in Yosemite National Park. J. Wildl. Manage. 48(1):140-146.

Hawley, V.D. and F.E. Newby 1957. Marten home ranges and population fluctuations. J. Mammal.38:174-184.

Koehler, G.M. and M.G. Hornocker 1977. Fire effects on marten habitat in the Selway-Bitteroot Wilderness. J. Wildl.Manag.41:500-505.

Martin, S. 1987. The ecology of the pine marten (Martes americana) at Sagehen Creek, California. PhD. Thesis. University of Calif.,Berkeley. 222pp.

Mech, L.D. and L.L.Rogers 1977. Status, distribution and movements of martens in northeastern Minnesota. USDA, Forest Service Res. Paper NC-143.7pp.

Simon, Teri 1980. Ecological study of the marten in the Tahoe National Forest, California. MS Thesis, Calif. St. Univ, Sacramento, Ca.143pp.

Simon-Jackson, Teri 1989. USDA, FS, R5-Fisheries and Wildlife Staff, San Francisco, CA. personal communications.

Simon-Jackson. and W.D. Spencer 1982. Managing for marten habitat. USDA, Forest Service, R5-San Francisco, Ca. 94111, 58pp.

Slough, B.G. 1989. Movements and habitat use by transplanted marten in the Yukon Territory. J. Wildl. Manage. 53(4):992-997.

Soutier, E.C. 1979. Effects of timber harvesting on marten in Maine. J. Wildl. Manage. 43:850-860.

Spencer, W.D. 1981. Pine marten habitat preferences at Sagehen Creek, Calif. MS Thesis. Univ. of Calif.,Berkeley. 121pp.

Steventon, J.D. and J. T. Major 1982. Marten use of habitat in a commercially clear cut forest. J. Wildl. Mgmt. 46:175-182.

Strickland, M.A. and C. W. Douglas 1987. Marten. In Wild furbearer management and conservation in North America. Ministry of Natural Resources. Ontario, Canada. pp. 531-546.

Suring, L.H., et al. 1988. Draft Habitat Capability Model for Marten in Southeast Alaska:Winter Habitat. USDA, Forest Service, R10-Alaska.

U.S. Dept. Agriculture, Region 6. 1986. Regional Land Management Planning Direction. A background document on the development and review of minimum management requirements (MMR) for forest planning on the national forest of the Pacific Northwest Region, USDA. References MMR letter of direction from April 16, 1984.

Warren, Nancy et al. 1989. Draft Old Growth Habitats guidelines: Marten pp. 4-1 to 4-11. Includes a draft Marten Habitat Relationships model. USDA, FS, R1, Missoula, Montana.

Wisconsin Department of Natural Resources 1986. Wisconsin pine marten recovery plan. Bureau of Endangered Resources, P.O. Box 7921, Madison, WI. 53707.

Wynne, K.M. and J.A. Sherburne 1984. Summer home range use by adult marten in northwestern Maine. Can. J. Zool. 62:941-943.